

greater than, equal to, or less than (I) (Art. 9, iii.). Lastly, every circle through F whose centre is on AF is inverse to a circle of the same kind as itself, as is also every circle passing through the points A and F.

(5) *When the origin A is on the fundamental conic (F)* the fundamental points B and C coincide with it, and the three principal lines coincide with the tangent at A. The conic (I) inverse to the line at infinity touches (F) at A and bisects all its chords through A, and the conic inverse to every other line in the plane has obviously three-pointic contact at A with (F). All lines which converge to one and the same point on the tangent at A are inverse to conics which have, at A, four-pointic contact with each other; hence right lines parallel to the tangent at A are inverse to conics having, at A, four-pointic contact with (I). Finally, the tangents to any two inverse curves, at inverse points p, p' , intersect on a line D which touches (F) at the intersection of this conic and pp' .

A still more special case, into the details of which we cannot enter, is *when the fundamental curve is a parabola, and the origin at the infinitely distant extremity of its axis*. Inversion relative to a conic and its focus is also a special case which merits attention, but cannot be here considered.

Transformation correlative to quadric inversion.

16. Corresponding to the method of quadric inversion, there is of course a correlative method, which in certain inquiries is equally useful. It does not, however, require a separate exposition. It may also be remarked that the reciprocal polar, relative to the fundamental conic, of the inverse of any primitive curve, and the inverse of its reciprocal polar, lead at once to derivative curves, of which negative and positive Pedal Curves are special cases.

II. "On the Marsupial Pouches, Mammary Glands, and Mammary Fœtus of the *Echidna Hystrix*." By PROFESSOR OWEN, F.R.S. Received February 18, 1865.

(Abstract.)

In a former communication on the generative economy of the *Monotremata**, the author showed that the ovum left the ovarium with a spherical vitellus $1\frac{1}{2}$ line in diameter, and had attained a diameter of $3\frac{1}{2}$ lines in the uterus, the increase of size being due to increase of fluid between the chorion and vitelline tunics. This fluid, homologous with the albumen of the egg of oviparous vertebrates, did not coagulate in alcohol, and the only change presented by the vitellus of the largest observed ovum was a separation from the "food-yolk" of a "germ-yolk" in the form of a stratum of very minute granules, adhering to part of the membrana vitelli. There was no

* "On the Ova of the *Ornithorhynchus paradoxus*," Philosophical Transactions, vol. cxxiv. p. 555

trace of decidua in such impregnated uteri; the smooth chorion was firmer than that of uterine ova of Rodentia; whence, and for other reasons given in the Paper above cited, it was inferred "that the *Monotremata* were essentially ovo-viviparous."

The impregnated uteri of the *Ornithorhynchus* there described were of females killed in the month of October. In the early part of December young *Ornithorhynchi*, obtained from the nest, were transmitted to the author: they were naked, blind, with short, broad, flexible, and softly labiate mandibles, the tongue proportionally large, and reaching to near the end of the mandibles; the mouth not round, as in the mammary fœtus of Marsupials, but a wide transverse slit; a pair of small patulous nostrils opened upon the upper mandible, and between them was a small prominence resembling the knob on the beak of the newly-hatched chick, but softer, and lacking the cuticle, which had been torn off. There was no trace of navel or umbilical cicatrix.

The phases of the development of the mammary glands of the *Ornithorhynchus* were the subject of another communication, and, with the peculiar formation of the mouth of the young animal, demonstrated that it was nourished by milk as other mammals. The smallest of the young of the *Ornithorhynchus* so obtained did not exceed two inches in length.

At the early part of the present year, the author received from Dr. Mueller, F.R.S., of the Botanical Gardens, Melbourne, Australia, a female *Echidna* (*Ornithorhynchus Hystrix*, Home, *Echidna Hystrix*, Cuv.), with a young one, which the captor found adhering to the mother, as he supposed, by a nipple. They were transmitted in spirits, and their description forms the chief subject of the present communication. In regard to the parent, the description is limited to the parts concerned in generation.

The marsupial pouches are first described. These are two in number, about $1\frac{1}{2}$ inch apart, each with the aperture longitudinal and towards the medial line, on the ventral integument, half an inch in depth and two-thirds of an inch in length. The young *Echidna*, about one inch in length in a straight line, could be received in a bent posture into the pouch, and might cling to the fine hairs of that part by its claws; but there was no trace of nipple. Each mammary gland terminates by numerous ducts upon the fundus of the corresponding pouch. The structure of the gland, the ducts, the surrounding muscles, and the pouch is described. The author next proceeds to give an account of the internal organs of generation of the female *Echidna*.

The left ovarium, as in the *Ornithorhynchus paradoxus*, was of an oblong flattened form, developed from the posterior division of the ovarian ligament and corresponding wall of the ovarian capsule; it consisted of a rather lax stroma, invested by a smooth, thin, firm "tunica propria," which glistens where stretched over the enlarged ovisacs. Of these there were five, of a spherical form, most of them suspended by a contracted part of their periphery, not stretched into a pedicle, to the rest of the

ovarium ; the largest with a diameter of $1\frac{1}{2}$ line, the least of the five with a diameter of rather less than 1 line. Besides these there was a flattened ovisac, $2\frac{1}{2}$ lines in length, and 2 lines in opposite diameters, of a flattened pyriform shape, with a somewhat wrinkled exterior, attached by the base, with the apex slightly tumid, and showing a trace of a fine cicatrix. This was an ovisac from which an ovarian ovum had been discharged.

The oviducal branch of the ovarian ligament passes, as in the *Ornithorhynchus*, to the outer angle of the wide oviducal slit or aperture, which occupies or forms the margin of the ovarian pouch opposite to that to which the ovary is attached. The ligament spreads upon the inner wall of the infundibular part of the oviduct, and rejoins the ovarian division of the ligament to be continued along the oviduct, puckering up its short convolutions into a small compass. The "fallopian" aperture of the infundibulum is a longitudinal slit of 9 lines in length, with a delicate membranous border extending about a line beyond where the muscular and mucous tunics of the oviduct make the thin wall of the infundibulum opaque, its transparency against a dark ground contrasting with the opaque beginning of the proper tunics of the oviduct, which nevertheless are here very thin. No part of this delicate free margin is produced into fimbriæ ; in this respect *Echidna* accords with *Ornithorhynchus*, and equally manifests the character by which the Monotremes differ from the Marsupials. The infundibular dilatation suddenly contracts about an inch from the opening into a "fallopian" tube, about a line in diameter, which is puckered up into four or five short close coils. The oviduct, after a slight contraction, suddenly expands into the uterus. This is about 2 inches long, and 6 lines in diameter. It commences by a short well-marked bend, convex outwards, and then proceeds nearly straight, the pair converging to the urogenital compartment, slightly contracting at its termination, which projects, as an "os tincæ," into the side of the fundus of that division of the cloaca.

The tunics of the uterus are, externally, the peritoneum, which is attached by a lax cellulosity to the "tunica propria;" this, with its fibrous or muscular layer, is thin, not exceeding $\frac{1}{8}$ th of a line in the present specimen. The inner layer of the uterine wall is the thickest, and chiefly composes it, consisting of fine lamellæ stretched transversely between the fibrous layer and the fine smooth lining membrane, the whole being of a pulpy consistence, and doubtless in the recent animal highly vascular, especially in the impregnated state. The lining membrane was devoid of any trace of vascular connexion with the membranes of an ovum or fœtus, and was thrown into delicate irregular rugæ, which assumed the longitudinal direction at the "cervix" or contracted terminal part of the uterus. The orifice on the "os tincæ" was a puckered slit, about a line in extent ; below it, on a produced or papillose part of the prominence, was the small circular orifice of the ureter.

The right ovary was proportionally more developed and larger than

in the *Ornithorhynchus paradoxus*: three ovisacs were developed and attached, as in the left ovarium; and there was also a compressed ovisac, similar in size and shape to that in the left side, and exhibiting an apical cicatrix, whence it is to be inferred that, in this instance, the right as well as the left ovarium had furnished an impregnated ovum; and the near equality of size and close similarity of structure and condition of the right oviduct and uterus equally indicated that they had participated in the functions of the last season of generation.

The urinary bladder opened into the middle of the fundus of the urogenital compartment, the uterine orifices intervening between the vesical one and the ureters, as in the *Ornithorhynchus paradoxus*. The urogenital canal is 1 inch 4 lines in length, and about 9 lines in diameter; its inner surface shows by some coarse wavy longitudinal rugæ its capacity for dilatation. The rectum was here of great width; it terminated by a contracted puckered aperture in the back part of the beginning of the vestibule, behind the aperture of communication of the urogenital with the vestibular canal. The distal half of the vestibule is lined by a denser and less vascular epithelium than the proximal one. The author concludes, from these appearances, that the present *Echidna* had produced two young, of which only one was secured, and that probably she had a mammary foetus in each pouch prior to her capture.

The one which was secured resembled the young of the *Ornithorhynchus* in the general shape and curvature of the body, and also resembled the new-born young of the Kangaroo in the proportions of the limbs to the body, in the inferior size of the hind pair, in the degree of development of the digits, especially of the fore pair, and in the feeble indication of eyes or eyelids. But the mouth is proportionally wider, and has the form of a transverse slit; it is not circular. Upon the upper lip, in the mid line between the two nostrils, is a small protuberance corresponding to that in the young of the *Ornithorhynchus paradoxus*, which had been covered by some epidermal production. The traces of ears are less conspicuous than in the young Kangaroo, the conch being little, if at all, developed in the mature *Echidna*.

The tail is much shorter than in the young Kangaroo, and shows as much proportional size as in the full-grown *Echidna*, in which it is a mere stump concealed by the quills and hair.

The head is proportionally longer and more slender in the marsupial foetus of the *Echidna* than in that of the *Ornithorhynchus* or of the Kangaroo, and already at this early period foreshows the characteristic elongation and attenuation of that part in the mature animal. The form of the mouth, as a transverse slit, is a good monotrematous character of the young at that period, since, in all true or teated marsupials, the mouth of the mammary foetus has a peculiar circular and tubular shape. A scarcely visible linear cicatrix at the middle of the lower part of the abdomen is the sole trace of umbilicus.

A bifid obtuse rudiment of penis or clitoris projects from the fore part of the single urogenital or cloacal aperture, and in advance of the base of the tail-stump.

The brain, of which the largest part was the mesencephalon, chiefly consisting of a vesicular condition of the optic lobes, had collapsed at this part, leaving a well-defined elliptical fossa of the integument, indicative of the widely open fontanelle at the upper part of the cranium*.

The skin of the shrunk body showed folds, indicative of the originally plump, well-filled abdomen.

The fore limbs, in their shortness and breadth, foreshowed the characteristics of those of the parent, which may be said, indeed, to retain in this respect the embryonic character, with superinduced breadth and strength. The digits have already something of the adult proportions, the first or innermost of the five being the shortest; the others of nearly equal length, but graduating shorter from the third to the fifth. The characteristic disposition of the digits was better marked in the hind limb, the second already being the strongest and longest, the rest more rapidly shortening to the fifth than in the fore leg. The innermost, agreeably with the law of closer retention of type in the embryo, though the shortest of the five, was less disproportionately so than in the adult.

After entering into other particulars, and quoting from correspondence on this subject of animal physiology, the author summarizes the chief points in the generative economy of the Monotremes, which still remain to be determined by actual observation as being—

1. The manner of copulation.
2. The season of copulation.
3. The period of gestation.
4. The nature and succession of the temporary structures for the nourishment and respiration of the fœtus prior to birth or exclusion.
5. The size, condition, and powers of the young at the time of birth or exclusion.
6. The period during which the young requires the lacteal nourishment.
7. The age at which the animal attains its full size.

In respect to the second point: as the female *Echidna* with the young, described in the present paper, was captured on the 12th of August, she might be impregnated at the latter end of June or in July. Females therefore, killed in the last week of July and the first week in August, in the province of Victoria, would be most likely to afford the capital facts noted under the "fourth" head, viz. the impregnated ovum *in utero*,

* In observations and illustrations of the development of the brain in Marsupialia (Phil. Trans. 1834), it is shown that, in the Kangaroo, some time after birth the chief and largest part of the brain is the mesencephalon, that the cerebellum is not more advanced than it is in Batrachian Reptiles, and that the cerebral hemispheres are even less developed: amongst the figures illustrative of this stage of formation of the marsupial brain is one of a dissection of the rudimentary hemisphere, showing the large and simple ventricular cavity then occupying it.

showing some stage of embryonal development in the spring terrestrial Monotreme. As to the hairy and aquatic *Ornithorhynchus*, the impregnated females in which ova were found in the uterus, of small size, and prior to the formation of the embryo, were caught on the 6th and 7th of October. Young *Ornithorhynchi*, measuring in length in a straight line 1 inch and $\frac{4}{5}$ ths, were found in the nest on the 8th of December. The period of impregnation, therefore, in this species, in the locality of the Murrumbidgee River, is probably the latter end of September or beginning of October. Females captured in the latter half of October and in the month of November, would be most likely to have ova *in utero*, exhibiting stages of embryonal development.

The author concludes by quoting a letter informing him that an *Ornithorhynchus* in captivity had laid two eggs, with a soft unvascular covering, each about the size of a Crow's egg. They were destroyed without examination. Had they been preserved in spirits or opened on the spot, the inference of the ovo-viviparous character of the animal might have been confirmed or otherwise. According to the Report, these alleged eggs must have resembled those of the Viper. Now the young Viper is provided with a specially and temporarily developed premaxillary tooth, for lacerating the soft, but tough, shell of its egg, and so liberating itself. From this analogy, the author conceives that the young Monotremes may be provided with a horny or epidermal process or spine upon the inter-narial tubercle for the same purpose. This temporary tubercle is obviously homologous with the hard knob on the upper mandible of chelonians and birds, by which they break their way through the harder calcareous covering of their externally hatched embryo.

The paper was illustrated by drawings of the female *Echidna*, of her marsupial pouches and young, of the mammary glands, and of the female organs of generation.

March 9, 1865.

Major-General SABINE, President, in the Chair.

The following communications were read :—

- I. "Numerical Elements of Indian Meteorology.—Series II. Insolation, and its Connexion with Atmospheric Moisture." By HERMANN VON SCHLAGINTWEIT. Communicated by the President. Received December 27, 1864.

(Abstract.)

The author regards as an approximate measure of insolation the difference of the maximum temperatures observed by two similar thermometers,